SANDIA NATIONAL LABORATORIES
Albuquerque, New Mexico 87185

Effective Date 2-4-94

TITLE: IMPLEMENTING PROCEDURE FOR CROSS-HOLE VELOCITY MEASUREMENTS

Prepared by: _____ Date: 1/25/94

SNL Reviewer: _____ Date: 1/25/94

SNL Approval: _____ Date: 1-25-94

SNL Safety Approval: _____ Date: 1-22-94

MOC Cognizant Department Manager Concurrence: _____ Date: 2-2-94

MOC Manager of Industrial Safety: _____ Date: 2-1-94

SNL QA Approval: _____ Date: 2-4-94

PURPOSE: The purpose of this procedure is to describe the process for making measurements of the velocity of compressional and shear elastic waves in situ at the WIPP.

RESPONSIBILITY: It is the responsibility of all people involved in making the velocity measurements to read this procedure.

SAFETY: This work will be done in the underground and access will be in accordance with existing WIPP Site requirements. When working with electrical equipment, no personnel will work with exposed connections. Personnel operating the HP216B pulse generator will read the operator's manual.

REFERENCES: N/A

EQUIPMENT:

I. Two transducer sets containing P (compressional mode) and S (shear mode) transducers, polarized parallel to the body of the transducer housing. These will subsequently be referred to as PS_V transducers. The "V" refers to vertically polarized.

II. Two transducer sets containing P (compressional mode) and S (shear mode) transducers, polarized perpendicular to the body of the transducer housing. These will subsequently be referred to as PS_H transducers. The "H" refers to horizontally-polarized.

III. Electrical pulse generator (HP216B)

IV. 60 db amplifier, AET Corporation or Physical Acoustics

V. Digital oscilloscope, Nicolet 4090

VI. Supply of floppy disks for oscilloscope

VII. Transducer emplacement tool

VIII. Flashlight

IX. Grease gun for filling transducer couplant chambers

X. Couplant (molasses)

XI. Transmit switch box

XII. Receiver switch box

XIII. Four - Steel rules, fifteen feet long, with at least .1 inch divisions

XIV. Attenuators for adjusting signal amplitude

FORMS: UltraSonic Wave Velocity data recording Form 286

QA RECORDS:

I. UltraSonic Wave Velocity data recording Form 286

II. Hole surveys

III. Field notes

PROCEDURE: All procedures are to be performed under the direction of the PI or his/her designate.

I. EQUIPMENT SETUP

See Figure 1.

A. Set sensitivity of channel 1 of the oscilloscope to +/- 10 volts.

B. Set pulse generator to "manual" mode so no pulses are present. Connect pulse generator output to channel 1 of the oscilloscope through a 10X attenuator. The pulse is a 1 millisecond, 100 volt square wave. The attenuator reduces the pulse amplitude from about 100 volts to about 10 volts to avoid damage to the oscilloscope.

C. Set sensitivity of channel 2 of the oscilloscope to +/- 100

millivolts.

D. Connect output of 60 db amplifier to channel 2 of the 4090 oscilloscope.

E. Connect pulse generator output to the transmit switch box.

F. Connect input of 60 db amplifier to the receiver switch box.

G. Apply power to amplifier, oscilloscope and pulse generator.

H. Set receive switch box to "P" position.

I. Set transmit switch box to "P" position.

J. Connect the P and S leads for one of the PS_V transducers to the transmit switch box. This transducer set will be called the transmitter.

K. Connect the P and S leads for the other PS_V transducers to the receive switch box. This transducer set will be called the receiver.

L. Bring the transmitter and receiver transducer heads together. See Figure 2 for location of transducer head on the transducer body.

M. Set the oscilloscope to trigger on Channel 1. A square wave pulse should be observed on Channel 1, corresponding to the output of the pulse generator. A transmitted wave should be observed on Channel 2, arriving 1 or 2 microseconds after the start of the square wave. Failure to observe the transmitted wave indicates a problem which must be rectified before proceeding. Check cabling, switch settings and as a last resort, try a different transducer.

N. Set the transmit and receive switches to the "S" position and repeat steps L. and M.

O. Repeat steps J. through M. with the PS_H transducers.

II. TRANSDUCER PREPARATION: Before each measurement, the transducer heads must be filled with couplant.

A. For both the transmitter and receiver transducers, wipe off excess couplant remaining from previous measurements and rock particles that may have adhered to the sticky couplant.

B. Using the grease gun and injector needle, refill the couplant chamber in the transducer head through the couplant holes (see Figure 2). The transducer head has about 1/8

1/8 inch of play and is forced out of the upper transducer body as the couplant is injected. When the couplant chamber is full the transducer head will be fully extended and a little couplant will squeeze out of the coupling grease holes.

C. Handle the transducers carefully to avoid extruding the couplant prematurely.

III. TRANSDUCER INSTALLATION: The receive and transmit transducers must be installed prior to each measurement. During installation it is important to get the insertion depths set accurately and the transducers properly oriented. Installation depths will be specified by the PI and will be determined from an examination of the core to determine depths to the marker bed in the actual test holes. A table of depths will be provided for each pair of holes.

A. Mount the transmitter transducer on the emplacement tool.

B. Determine the insertion depth for the transmitter transducer from the table of depths.

C. Mark the depth on the emplacement tool using a fine point marker. Depth is measured from the center of the transducer body, using the steel tapes.

D. Insert the transducer-emplacement tool assembly into the borehole with the transducer head facing toward the matching receiver borehole. Match the depth mark on the insertion tool with the reference point marked on the reference plate (see Figure 3).

E. Visually align the axis of the transducer body with the line connecting the transmit and receive boreholes, making sure that the transducer head is pointing toward the receiver borehole.

F. Unclamp the transducer from the emplacement tool, being careful to maintain alignment and depth.

G. Repeat the installation for the receiver transducer.

IV. MEASUREMENT PROCEDURE

A. Set the transmit and receive switches to the "P" position.

B. Observe that the square wave transmitted pulse (Channel 1) and the received pulse are on scale. The beginnings of the square wave pulse and the first few peaks of the received pulse should be clearly visible on screen. The first two peaks of the received pulse should be on scale with no clipping. Adjust the square wave amplitude if necessary to

lower the amplitude of the received signal.

C. Record the signals on the floppy disk drive built into the oscilloscope.

D. Record the measurement information on the data form, Form 286.

E. Verify that the data has been properly recorded on the floppy disk. To do this allow the oscilloscope to trigger, recording a new signal. Then recall the previously-stored signals, while observing the screen. If the signals were properly stored, the screen display will change as the recorded signals overwrite the displayed signals. Improper storage will result in no signal being recalled and the display will not change. It is also possible to get a bad recording. In that case, the recalled signals will be obviously distorted and the recording must be done again, as in steps II, III, and V.

F. Make a quick determination of the travel time using the cursor controls of the oscilloscope and record on form 286. This provides a further backup against data loss and a consistency check. The travel times should not vary much from one measurement to the next. Gross changes of more than a few percent are cause to recheck the data.

G. Set the transmit and receive switches to the "S" position and repeat the measurement procedure.

V. TRANSDUCER REMOVAL

A. Replace the insertion tool and use it to clamp the transducer body to the tool.

B. Remove the tool and transducer body from the borehole.

C. Repeat for the other transducer.

The steps under TRANSDUCER PREPARATION, TRANSDUCER INSTALLATION, MEASUREMENT PROCEDURE AND TRANSDUCER REMOVAL are repeated for each of the measurement depths using the PS_V transducers. Then the process is repeated using the PS_H transducers. Finally the whole process is repeated for the other two sets of boreholes.

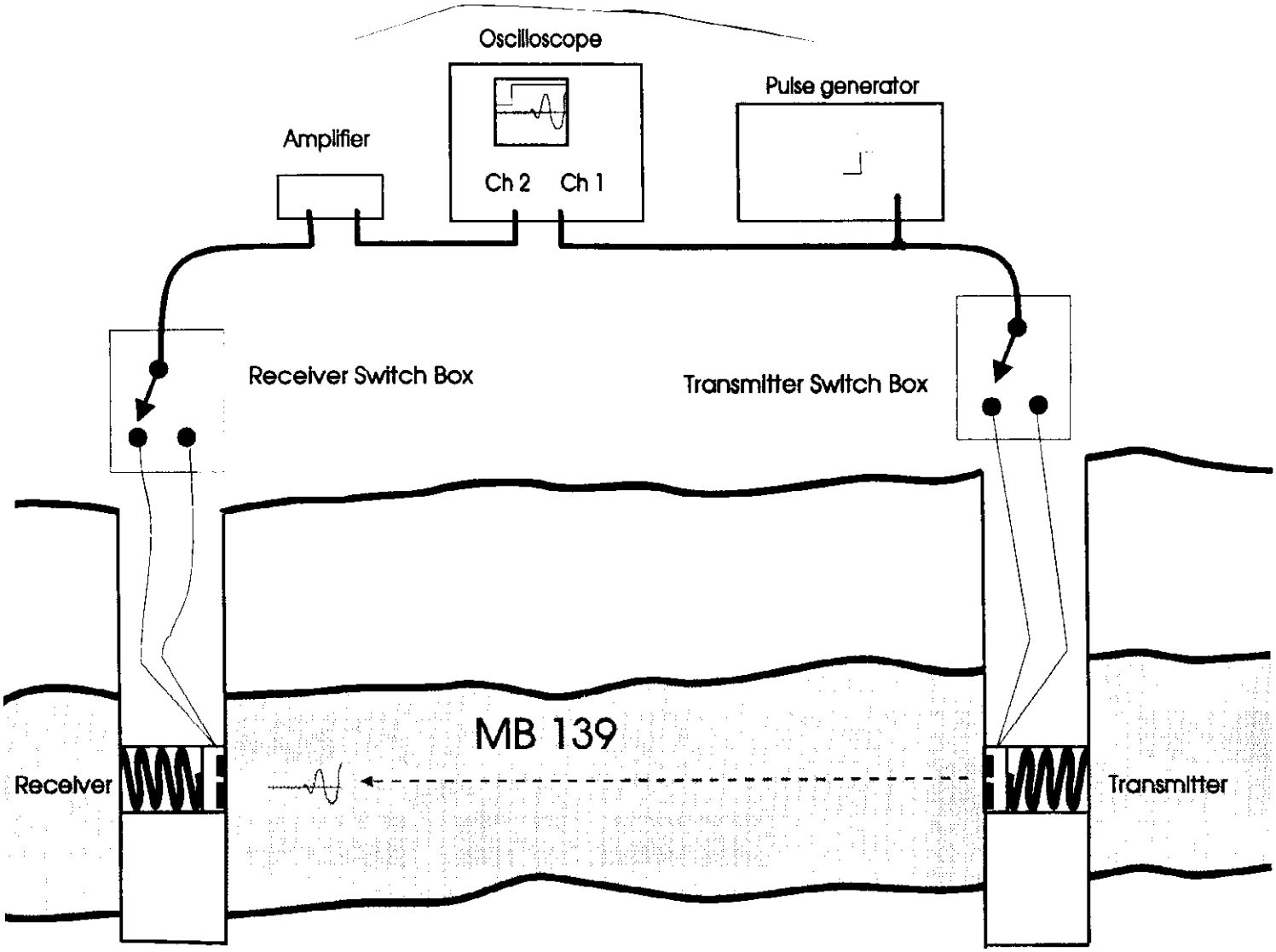

Figure 1. Layout and connection diagram for velocity measuring equipment.

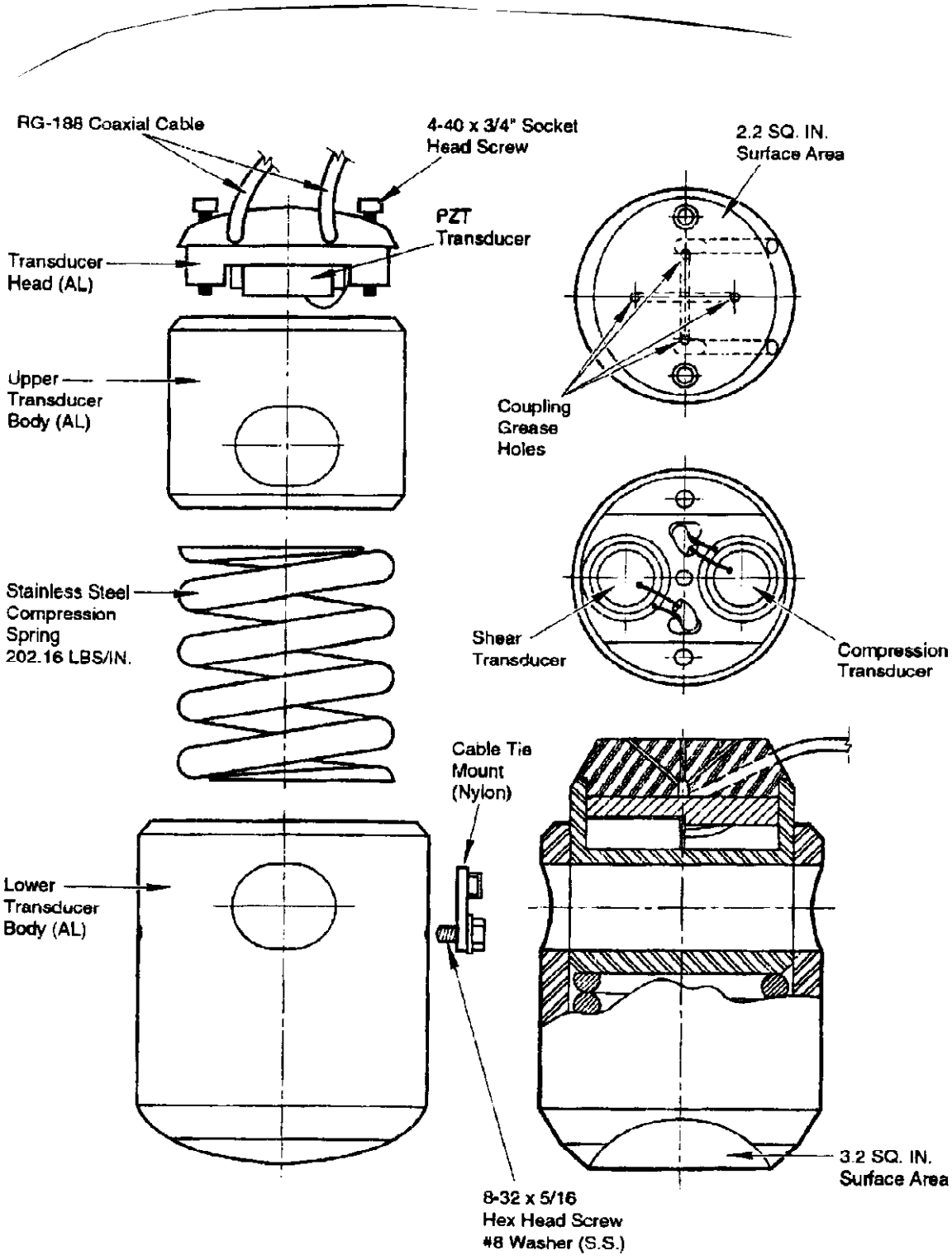

Figure 2. Transducer diagram

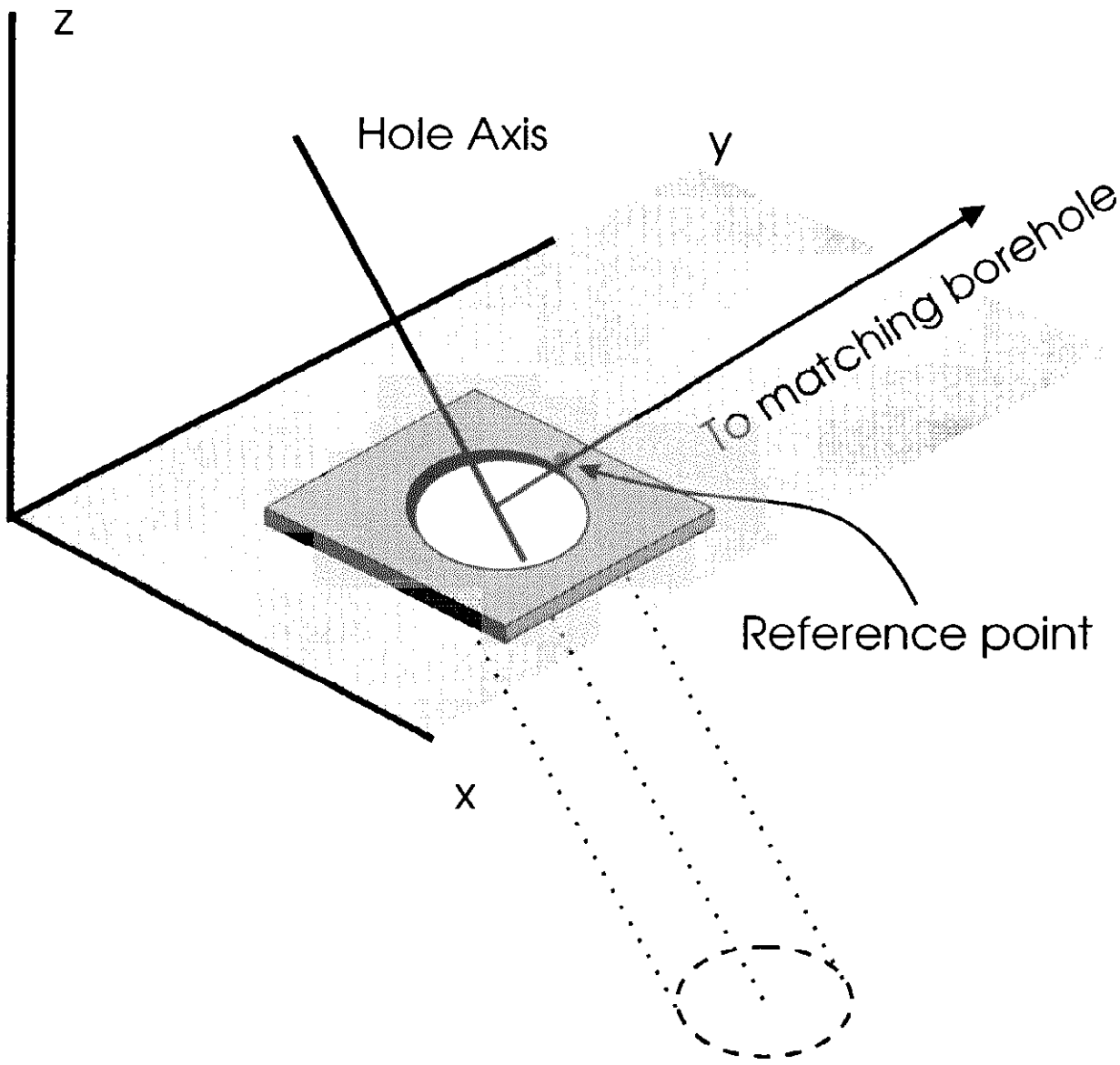

Figure 3. Orientation diagram for transducer installation.

REVISION SUMMARY

To be completed by procedure's author before final revision is circulated for signatures.

I. Revisions made: New Procedure

II. Personnel effected:

(Check appropriate ones)

MOC Craftsman		SNL JOB AREA	
Drilling	____	DAS General	____
Shop	____	DAS B49 Trailer	____
Mechanical	____	DAS Sheds	____
Electrical	____	DAS Equip. Cal. & Inv.	____
Gage	____	Thermocouple	____
Cable/TC	____	Cables	____
U/G DAS	____	Drilling	____
Geotech	____	Gage Installation	____
		Gage Cal. & Removal	____
		Plugging & Sealing	____
		Brine Transport	____
		QA	____
		General	____
		Principal Investigator	____
		Bin Leak Tester	____
		Permeability Testing	____

III. Retraining required:

(Circle One)

(Read/Re-read procedure)

Practical demonstration

Other (explain)

Personnel performing work will read procedure

Signature of Procedure's Author David J. Richard Date 1-26-94